

AD-A235 621 TION PAGE

Form Approved
OMB No. 0704-0188

2



average 1 hour per response, including the time for reviewing instructions, searching existing data sources, the collection of information. Send comments regarding this burden estimate or any other aspect of this Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. DATE		3. REPORT TYPE AND DATES COVERED	
		5-3-91		Annual Technical 4/1/90-3/31/91	
4. TITLE AND SUBTITLE				5. FUNDING NUMBERS	
Numerical & Symbolic Signal Representation and Processing				N00014-89-J-1489	
6. AUTHOR(S)				4119351-04	
Prof. Alan Oppenheim					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)				8. PERFORMING ORGANIZATION REPORT NUMBER	
Research Laboratory of Electronics Massachusetts Institute of Technology 77 Massachusetts Avenue Cambridge, MA 02139					
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
Office of Naval Research 800 North Quincy Street Arlington, VA 22217					
11. SUPPLEMENTARY NOTES					
The view, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.					
12a. DISTRIBUTION/AVAILABILITY STATEMENT				12b. DISTRIBUTION CODE	
Approved for public release; distribution unlimited.					
13. ABSTRACT (Maximum 200 words)					
Work by Prof. Oppenheim and his collaborators is summarized here					
14. SUBJECT TERMS				15. NUMBER OF PAGES	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT		
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL		



DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

C A M B R I D G E , M A S S A C H U S E T T S 0 2 1 3 9

Room 36-615
Tel. (617) 253-4177

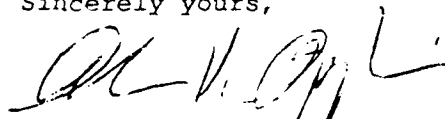
May 1, 1991

Group Leader-Information Sciences
Associate Director for Engineering Sciences
Office of Naval Research
Department of the Navy
800 North Quincy Street
Arlington, Virginia 22217

During the period of April 1, 1990, through March 31, 1991, our research activities focussed on continuing work on symbolic signal processing, new algorithms for signal analysis, and new signal representations based on wavelet analysis.

Our work on this contract during the past year has been reported in detail in the technical literature through technical reports, conference proceedings, and journal articles. Copies of these reports have been provided to the contract monitor and other offices as specified in the contract. Additional copies are available on request.

Sincerely yours,


Alan V. Oppenheim
Distinguished Professor
of Electrical Engineering



AVO/dag

Encl.

SEARCHED	INDEXED
SERIALIZED	FILED
MAY 1 1991	
FBI - BOSTON	
A-1	

Publications

- [1] Alan V. Oppenheim, "Nonlinear Filtering of Multiplied and Convolved Signals", (with R.W. Schafer and T.G. Stockham, Jr.), (*Proceedings of the IEEE*, 1968), reprinted in Section Seven ("Image Enhancement") of Selected Papers on Digital Image Processing, SPIE Milestone Series, Volume MS 17, SPIE Optical Engineering Press, SPIE, Bellingham, Washington, 1990, pp. 480-507.
- [2] Alan V. Oppenheim, "Reconstruction of Multidimensional Signals from Zero Crossings", (with Susan R. Curtis), Chapter 5 of Image Understanding 1989, Ed. Shimon Ullman and Whitman Richards, Ablex Publishing Corp., Norwood, New Jersey, 1990.
- [3] Michele M. Covell, "An Algorithm Design Environment for Signal Processing", Proceedings, ICASSP90, Albuquerque, NM, April 3-6, 1990.
- [4] Paul E. Beckmann and Bruce R. Musicus, "Fault-Tolerant Round Robin A/D Converter System", Proceedings, ICASSP90, Albuquerque, NM, April 3-6, 1990.
- [5] Gregory W. Wornell, "A Karhunen-Loeve-like Expansion for $1/f$ Processes via Wavelets", Correspondence, IEEE Trans. on Information Theory, Vol. 36, No. 4, July 1990, pp. 859-861.
- [6] Ehud Weinstein, Meir Feder, and Alan V. Oppenheim, "Sequential Algorithms for Parameter Estimation Based on the Kullback-Liebler Information Measure", IEEE Trans. on ASSP, Vol. 38, No. 9, September 1990, pp. 1652-1656.
- [7] Mordechai Segal, Ehud Weinstein, and Bruce R. Musicus, "Estimate-Maximize Algorithms for Multichannel Time Delay and Signal Estimation", IEEE Trans. on Signal Processing, Vol. 39, No. 1, January 1991, pp. 1-16.

Articles Submitted for Publication or To Be Published

- [8] Michele Covell and John Richardson, "A New, Efficient Structure for the Short-Time Fourier Transform, With an Application in Code-Division Sonar Imaging", accepted for Proceedings, International Conference on Acoustics, Speech, and Signal Processing, ICASSP91, May 14-17, 1991, Toronto, Ontario, Canada.
- [9] James C. Preisig, "A Robust High Resolution Array Processing Algorithm Based Upon Minmax Criteria", accepted for Proceedings, ICASSP91, May 14-17, 1991, Toronto, Ontario, Canada.
- [10] M. Tabei, B.R. Musicus, and M. Ueda, "A Maximum Likelihood Estimator for Frequency and Decay Rate", accepted for Proceedings, ICASSP91, May 14-17, 1991, Toronto, Ontario, Canada.
- [11] Ehud Weinstein, Meir Feder, and Alan V. Oppenheim, "Multi-Channel Signal Separation Based on Decorrelation", submitted to IEEE Trans. on Signal Processing.
- [12] Gregory W. Wornell, "Communication over Fractal Channels", accepted for Proceedings, ICASSP91, May 14-17, 1991, Toronto, Ontario, Canada.

- [13] Gregory W. Wornell and Alan V. Oppenheim, "Estimation of Fractal Signals from Noisy Measurements Using Wavelets", to be published in IEEE Trans. on Signal Processing.
- [14] Gregory W. Wornell and Alan V. Oppenheim, "Fractal Modulation Based on Deterministically Self-Similar Signals", submitted to IEEE Trans. on Information Theory - Special Issue on Wavelet Transforms and Multi-Resolution Signal Analysis.

Technical Reports

- [15] Daniel T. Cobra, "Estimation and Correction of Geometric Distortions in Side-Scan Sonar Images", RLE Technical Report No. 556, May 1990, Research Laboratory of Electronics, MIT, Cambridge, MA.
- [16] E. Weinstein, A.V. Oppenheim, and M. Feder, "Signal Enhancement Using Single and Multi-Sensor Measurements", RLE Technical Report No. 560, November 1990, Research Laboratory of Electronics, MIT, Cambridge, MA.
- [17] Paul E. Beckmann and Bruce R. Musicus, "Fault-Tolerant Round Robin A/D Converter System", RLE Technical Report No. 561, December 1990, Research Laboratory of Electronics, MIT, Cambridge, MA.

Contributed Presentations

- [18] Alan V. Oppenheim, invited presentation, "Chaos, Fractals & Signal Processing", Symposium on the Applications of Wavelets to Signal Processing, Wright-Patterson Air Force Base, Ohio, March 20-22, 1991.
- [19] Alan V. Oppenheim, plenary speaker, "Chaos, Fractals & Signal Processing", Third Biennial Mini Conference on Acoustics, Speech, and Signal Processing, Henderson House, Northeastern University, Weston, MA, April 19, 1991.

Office of Naval Research

DISTRIBUTION LIST

Neil L. Herr, Scientific Officer

Code: 11115P

Office of Naval Research
800 North Quincy Street
Arlington, VA 22217

3 copies

Administrative Contracting Officer
E19-628
Massachusetts Institute of Technology
Cambridge, MA 02139

1 copy

Director
Naval Research Laboratory
Washington, DC 20375
Attn: Code 2627

6 copies

Defense Technical Information Center
Bldg. 5, Cameron Station
Alexandria, VA 22314

2 copies



RESEARCH LABORATORY *of* ELECTRONICS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASSACHUSETTS 02139

May 3, 1991

Neil L. Gerr
Scientific Program Officer
Code: 1111SP
Office of Naval Research
800 North Quincy Street
Arlington, VA 22217-5000

Re: Contract No. N00014-89-J-1489

Type of Material:	Annual Technical Report
Title:	Numerical & Symbolic Signal Representation & Processing
Submitted by:	Prof. Alan Oppenheim
Period covering:	April 1, 1990 - March 31, 1991
Number of Copies:	Three plus form 298
Distribution:	Navy Distribution List (9)

Mary S. Greene
Publications Office
RLE 36-464

cc: A. Oppenheim (1)
D. Duffy
A. Favaloro, E19-702
File (1)

OSP 71695